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22. (New) An information processing apparatus provided with at least one probe selected from the group consisting of probes produced by a method according to any one of claims 10 to 16.

23. (New) A probe according to claim 1, wherein said mirror is a slanted face.--

REMARKS

Claims 1-5, 7 and 9-23 are now presented for examination. Claims 1, 10-12, 14 and 16-19 have been amended to define still more clearly what Applicants regard as their invention. Claims 6 and 8 have been cancelled without prejudice. Claims 20-23 have been added to provide Applicants with a more complete scope of protection. The specification has been amended as to matters of form, including those kindly pointed out in the Office Action.

Claims 1 and 10 are the only independent claims.

Claims 17-19 were objected to as being in improper multiple dependent form. Claims 17-19 have been amended and are now believed to be in proper multiple dependent form. New Claims 20-22 are added to cover the subject matter deleted in the amendment to Claims 17-19. Claims 10 and 16 were objected to because of informalities that have been corrected by amendment.

Claims 9 and 17-19 were rejected under 35 U.S.C. § 112, second paragraph, as indefinite. The claims have been carefully reviewed and amended as deemed necessary to ensure that they conform fully to the requirements of Section 112, second paragraph, with special attention to the points raised in the Office Action. In particular, the mirror is

now recited in Claim 1, the claim from which Claim 9 depends. As to Claims 17-19, the amendments to those claims discussed above are believed to obviated this rejection. It is believed that the rejection under Section 112, second paragraph, has been obviated, and its withdrawal is therefore respectfully requested.

Claims 1, 6, 8 and 9 were rejected under 35 U.S.C. § 102(e) as anticipated by U.S. Patent 6,396,050 (Yamamoto et al.). Claims 2-4 were rejected under 35 U.S.C. § 103 as obvious from Yamamoto et al. Claims 5, 7, 10-14 and 16 were rejected under 35 U.S.C. § 103 as obvious U.S. Patent 5,354,985 (Quate) in view of Yamamoto et al.. Claim 15 was rejected under 35 U.S.C. § 103 as obvious from Quate in view of Yamamoto et al. and further in view of U.S. Patent 5,902,715 (Tsukamoto et al.).

Amended Claim 1 is believed patentable over the prior art for at least the following reasons.

Claim 1 is directed to a probe for detecting light or irradiating light, comprising: a cantilever supported at an end thereof by a substrate; a hollow tip formed at a free end of the cantilever; a microaperture formed at the end of the tip; a hollow waveguide formed inside the cantilever; and a mirror at an end of the hollow waveguide at the tip side, wherein the direction of the end of the substantially perpendicular to the longitudinal direction of the cantilever, and the mirror reflects the light entering from the microaperture toward the hollow waveguide or reflects the light transmitted in the hollow waveguide toward the microaperture.

Yamamoto et al. is cited in the Office Action as teaching a concave mirror (reference numeral 8 (right side) of Fig. 3) inside the probe to guide light from the waveguide to the microaperture. The concave mirror, however, is one of two mirrors located at both ends of the waveguide respectively and facing each other to amplify a light

trapped in the waveguide (see col. 4, lines 39-44 and Fig. 3). As a result, part of the light incident upon one of the mirrors passes through the mirror and part of the light is instead reflected toward the other mirror.

On the other hand, the mirror recited in amended Claim 1 reflects a light incident from the aperture into the waveguide directly, and reflects light incident from the waveguide on the aperture directly. This constitution is realized, for example, by locating the mirror at the aperture end of the waveguide so as to have the slanted or concave face.

The location and reflecting function of the mirror as recited is especially advantageous when the waveguide and the probe are orthogonally located with respect to each other and are hollow. This is because the optical path from the waveguide to the probe is not discontinuous in refractive index and light goes straight accordingly. Hence a design of the angle of the mirror and the location of the aperture for maximizing the efficiency of transmitting a light from aperture to waveguide or from waveguide to aperture can be carried out very easily.

The mirror in Yamamoto et al. is different from that recited in amended Claim 1 in not reflecting directly the light of the waveguide toward the aperture. Yamamoto et al. includes a description of an example in which a fiber was bent to locate the waveguide and the aperture orthogonally (Example 6 and Fig. 6B). Even in the case of using the mirror of Fig. 3 in the example, it is not believed the resultant structure would improve the transmitting efficiency of light in the bending portion of the waveguide.

For at least the above reasons, amended Claim 1 is believed patentable over Yamamoto.

Claim 10 recites a method for producing a probe for light detection or light irradiation. The method comprises the steps of: working a substrate to form a groove and

a mirror at an end of the groove therein, forming a flat plate-shaped cover portion on the groove to form a hollow waveguide having an opening in a part thereof, forming a hollow tip having a microaperture on the opening, and removing a part of the substrate by etching, to form a cantilever.

Quate shows that the direction of a waveguide in a cantilever and the direction of an aperture at the tip of a probe are orthogonal to each other. In addition, a waveguide 23 of a probe of Example 1 as shown in Figs. 1A to 1D of Quate is made of thin film of silicon nitride (column 3, lines 27-29). Example 2 (Figs. 5A to 5D) also discloses waveguide 51 made of silicon nitride, in which example a metal (Cr/Au) film 54 is formed on an upper face of the waveguide. The thin film propagates a light and the light is introduced into an aperture through a thin film made of silicon nitrate, the same material as the waveguide (column 3, lines 4-7; column 8, lines 20-23). The probe has a cone or pyramid portion which are similar to the pyramid tip in the present invention (The probe of Figs. 5A to 5D in Quate is hollow). However, since it is the silicon nitrate thin film that the light is propagated in, this portion does not function as an optical path. As a result, the orthogonal angle between the above-mentioned directions has no relationship to the transmission by reflection of light. Consequently, those skilled in the art would not have conceived joining optically the waveguide in the cantilever to the aperture at the tip of probe by the mirror on the basis of this teaching.

It might appear that the mirror in Quate has the same function as that recited in the claims since light through the waveguide is reflected at the slanted portion of probe 52 because of the upper face of waveguide 51 covered with metal film 54. However, even if the light in the waveguide is reflected by the metal film on the slanted portion of the probe, the slanted portion does not reflect the light in the waveguide toward the aperture at

the tip of probe 52. To the contrary, the reflected light might come through the side where the metal film 54 does not exist, i.e. the under face, toward the outside of the waveguide. Quate's mirror thus does not exhibit the advantageous effect of increasing the transmitting efficiency that is a characteristic of the claims of the present invention.

Generally speaking, it is indispensable for the accurate introducing of light into the aperture of the tip to set the mirror to a suitable position at the end of the waveguide thus enabling the aperture to come into view. By virtue of the method of Claim 10, it possible to set the position and angle of mirror accurately because the waveguide and the mirror are prepared by photolithography and etching process to silicon in the present invention. In comparison with this, the reflecting film is casually formed on the slant face of the probe in the constitution of Figs. 5A to 5D of Quate, and the location and angle therefore are naturally inappropriate. Consequently, even if the hollow fiber of Yamamoto et al. is combined with the disclosure of Quate, the resultant structure would have suggested neither the structure nor the processes of the claims of the present invention. Accordingly, Claim 10 is believed patentable over the cited art.

A review of the other art of record has failed to reveal anything which, in Applicants' opinion, would remedy the deficiencies of the art discussed above, as references against the independent claims herein. Those claims are therefore believed patentable over the art of record.

The other claims in this application are each dependent from one or another of the independent claims discussed above and are therefore believed patentable for the same reasons. Since each dependent claim is also deemed to define an additional aspect of the invention, however, the individual consideration or reconsideration, as the case may be, of the patentability of each on its own merits is respectfully requested.

In view of the foregoing amendments and remarks, Applicants respectfully request favorable reconsideration and early passage to issue of the present application.

Applicants' undersigned attorney may be reached in our New York office by telephone at (212) 218-2100. All correspondence should continue to be directed to our below listed address.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE TO CLAIMS

1. (Amended) A probe for detecting light or irradiating light, comprising:

a cantilever supported at an end thereof by a substrate;

a hollow tip formed at a free end of [the] said cantilever;

a microaperture formed at the end of [the] said tip; [and]

a hollow waveguide formed inside [the] said cantilever; and

a mirror at an end of said hollow waveguide at the tip side, wherein the direction of the end of said substantially perpendicular to the longitudinal direction of said cantilever, and said mirror reflects the light entering from the microaperture toward the hollow waveguide or reflects the light transmitted in said hollow waveguide toward said microaperture.

6. (Cancelled)

8. (Cancelled)

10. (Amended) A method for producing a probe for light detection or light irradiation, which comprises the steps of:

working a substrate to form a groove and a mirror at an end of the groove therein,

forming a flat plate-shaped cover portion on the groove to form a hollow waveguide having an opening in a part thereof,

forming a hollow tip having a microaperture on the [opeining] opening, and

removing a part of the substrate by etching, to form a cantilever.

11. (Amended) The method according to claim 10, wherein said groove [is] <u>and said mirror are</u> formed by etching said substrate.

12. (Amended) The method according to claim 11, wherein said groove [is] <u>and said mirror are</u> formed by crystal-anisotropic etching of said substrate.

13. (Not Currently Amended) The method according to claim 10, further comprising a surface treatment step of forming said groove or said cover portion into a mirror surface state.

14. (Amended) The method according to claim 10, wherein said cover [portions] <u>portion</u> is formed from an SOI (silicon on insulator) layer of an SOI substrate.

15. (Not Currently Amended) The method according to claim 10, wherein said cover portion is formed by filling said groove with a resin layer and forming a metal film on said resin layer.

16. (Amended) The method according to claim 10, wherein said step of forming said hollow tip having said microaperture on said opening comprises the steps of:

forming a film of a tip material on a recess formed on a substrate,

transferring the tip material onto the opening, and

etching the end of a [follow] <u>hollow</u> tip resulting from the transferring step

to form the microaperture.

17. (Amended) The surface observation apparatus provided with at least one probe selected from the group consisting of probes according to any one of claims [1 to 9 and probes produced by a method according to any one of claims 10 to 16] 1 to 5, 7 and 9.

18. (Amended) An exposure apparatus provided with at least one probe selected from the group consisting of probes according to any one of claims [1 to 9 and probes produced by a method according to any one of claims 10 to 16] 1 to 5, 7 and 9.

19. (Amended) An information processing apparatus provided with at least one probe selected from the group consisting of probes according to any one of claims [1 to 9 and probes produced by a method according to any one of claims 10 to 16] 1 to 5, 7 and 9.

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VERSION WITH MARKINGS TO SHOW CHANGES MADE TO SPECIFICATION

The paragraph beginning at page 1, line 14 has been amended as follows:

--Since the development of the scanning tunneling microscope (hereinafter represented as STM) (G. Binnig et al., Phys. Rev. Lett, 49, 57(1982)) capable of directly observing the electronic structure of surfacial atoms of a [coductor] conductor has enabled the measurement of both monocrystalline and amorphous materials with a high resolution in a real spatial image, the scanning probe microscopes (SPM) are being actively investigated in the field of evaluation of microstructures of various materials. Among the SPM, there are known a scanning tunneling microscope (STM), an atomic force microscope (AFM), a magnetic force microscope (MFM) etc. which detect the surfacial structure by a tunneling current, an atomic force, a magnetic force, a light etc. obtained by positioning a probe with a [micrio-tip] micro-tip close to a specimen to be evaluated.--

The paragraph beginning at page 4, line 18 has been amended as follows:

--In consideration of the foregoing, the object of the present invention is to provide a light detecting or irradiating probe capable of reducing the light transmission loss between the waveguide and the optical microaperture or that in the short wavelength region in the waveguide while maintaining the advantage of fabricating easily a plurality of the [proves] probes by easy integration and easy size reduction in the method of the aforementioned Japanese Patent Application Laid-open No. 10-293134, which probe can be fabricated by a batch process with a high productivity and a satisfactory process reproducibility of the optical microaperture, a producing method therefor, a surface observation apparatus, an exposure apparatus and an

information processing apparatus.--

The paragraph beginning at page 5, line 27 has been amended as follows:

--forming a hollow tip having a microaperture on the [opeining] <u>opening</u>, and--

The paragraph beginning at page 15, line 26 has been amended as follows:

--It is also possible to provide a surface observation apparatus, an exposure [apparatur] <u>apparatus</u> or a recording-reproducing apparatus of a high transfer rate by parallel processing of information utilizing a multi-probe utilizing the configuration of the [preseent] <u>present</u> invention. The recording medium in such application can be, as an example of the recording medium showing a change in the optical characteristics by a voltage application, a diacetylene derivative polymer such as 10, 12-pentacosadiinic acid which causes a change in the structure by Joule's heat resulting from a local current generated by a voltage application thereby showing a shift in the peak wavelength of the light absorption band, as described in the Japanese Patent Application Laid-open No. 4-90152. Also as an example of the recording medium showing a change in the optical characteristics by a voltage application under light irradiation, there can be mentioned an azo compound having a quinone radical and a hydroquinone radical showing a cis-trans photomesomeric reaction only under light irradiation to form a redox pair and showing a proton migration in such redox pair under the application of an electric field, as disclosed in the Japanese Patent Application Laid-open No. 2-98849.--